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Although the fluctuations in brightness have continued, the star does not seem to have varied to the same extent as formerly. The observations show that the star was more or less bright on the following dates: May 13, 17–18 (slight), 22, and June 8. Apart from these temporary or periodical fluctuations, the *Nova* seems to have remained almost stationary during the past month.

Observations of colour have been practically impossible lately owing to the low altitude, but on May 13 the star seemed strongly reddish, and on May 14 it was noted as being evidently a very deep red. On May 22, when the star was bright, it appeared as a flaming bright star of a pronounced red colour, even at $9^h\ 45^m$, when the altitude was very low. On June 8, at $13^h\ 55^m$, the colour seemed to be orange.

1901 June 12.

Secular Variation in the Period of R Carinæ.

By Alexander W. Roberts, D.Sc.

The periods of several of the Southern Long Period Variables seem subject to secular variation, but with the exception of *R Carinæ* the observations are either too discontinuous or too meagre to afford even a remote idea of the amount and nature of the variation.

With regard to *R Carinæ* sufficient observations have, I think, accumulated during the past twenty years to indicate the salient characteristics of the irregularities which affect its variation.

The first observation of which we have any record is that made by Lacaille on 1752 March 3. As Lacaille estimated it as of the seventh magnitude, it could not then have been far from its maximum brightness. This observation is therefore of importance as fixing within certain limits the period of the variable.

In 1867 two meridian observations of *R Carinæ* were made very near a maximum phase by Ellery at Melbourne.

The two observations are :—

1867 March 31 ... ... Magnitude 6·5
„ April 3 ... ... „ 6·0

This, taking the average rate and extent of variation of *R Carinæ*, would mean a maximum on or about 1867 April 25.

The observations made by Brisbane and Stone are not of value in any investigation dealing with the light changes of *R Carinæ*, as position rather than brightness was the purpose of their observations. It is indeed possible that Stone simply copied Lacaille's magnitude into his observation book.

The discovery of the variation of *R Carinæ* was made by Gould in 1871, and during this and the following three years continuous observations were made of it at Cordoba.

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These yielded (*Uranometria Argentina*, p. 251) the following four maxima dates :—

1871 July 17	...	...	Julian Day 2404626
1872 June 10	...	...	,, 2404955
1873 April 12	...	...	,, 2405261
1874 March 4	...	...	,, 2405587

The long and highly valuable series of observations made by Tebbutt, at Windsor, New South Wales, was begun in 1880. Without these earlier observations by this indefatigable worker, an investigation of the secular inequalities of *R Carinæ* would not, I think, be possible at the present date.

In 1891 regular observations were begun at Lovedale, and have been carried on until now with only one short interval. We have accordingly continuous observations of *R Carinæ* for over twenty years. If we include Gould's observations the series extends, with one break, over thirty years.

The following list gives the various maxima which have been determined, beginning with the estimated maximum of 1867 (Melbourne).

Rotation No.	Maximum.	Julian Day.	Observed at.
1	1867 April 25	2403082	Melbourne
2	1871 July 17	2404626	Cordoba
3	1872 June 10	2404955	,,
4	1873 April 12	2405261	,,
5	1874 March 4	2405587	,,
6	1880 Dec. 16	2408066	Windsor
7	1881 Oct. 21	2408375	,,
8	1882 Aug. 30	2408688	,,
9	1883 July 6	2408998	,,
10	1884 May 24	2409321	,,
11	1885 April 5	2409637	,,
12	1886 Jan. 27	2409934	,,
13	— Dec. 8	2410249	,,
14	1887 Oct. 13	2410558	,,
15	1889 June 23	2411177	,,
16	1890 April 13	2411471	,,
17	1892 Jan. 1	2412099	Lovedale
18	— Nov. 3	2412406	,,
19	1893 Aug. 25	2412701	,,
20	1894 July 2	2413012	,,
21	1895 May 11	2413325	,,
22	1898 Sept. 15	2414548	,,
23	1899 July 12	2414848	,,
24	1900 May 17	2415157	,,
25	1901 March 20	2415465	,,

As already stated, the observation made by Lacaille is of importance as indicating between what limits the mean value of the period of *R Carinæ* must lie. Lacaille's observation was

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made on 1752 March 3, the magnitude on that date being 7·0. Now either *R Carinæ* was then rising to its maximum brightness or it had already passed it. An examination of the mean light curve indicates that *R Carinæ* passes what is apparently Lacaille's seventh magnitude standard 50 days before maximum or about 80 days after it. That is, in 1752 the maximum of *R Carinæ* took place either about January 23 or about May 22. The former date when related to recent maxima yields a period of 309·7 days, and the latter date 309·0 days. Between these two values the mean period of *R Carinæ* must lie.

In a recent catalogue of Southern Variable Stars (*Astronomical Journal*, vol. xxi. p. 85) I considered the former of the two values, 309·7 days, as the one which most closely corresponds with observation. With this period as a known quantity, the full elements of variation are :—

$$\text{(I.)}\quad M = 2415180 + 309^{d}{\cdot}7\,E + 25^{d}\cos(10^\circ E - 180^\circ)$$

That is, a full cycle of the inequalities affecting the period of *R Carinæ* is completed in about thirty-one years.

With these elements the maximum dates given in column 4 have been computed. Column 5 gives the residuals between the dates so computed and the observed dates (column 3).

			I.		II.	
Rotation No.	E	Observed Max. J.D.	Computed Max. J.D.	O–C	Computed Max. J.D.	O–C
				d		d
1	−39	2403082	2403080·1	+ 1·9	2403086·5	− 4·5
2	34	2404626	2404626·8	− 0·8	2404636·5	−10·5
3	33	2404955	2404938·3	+16·7	2404947·7	+ 7·3
4	32	2405261	2405250·4	+10·6	2405259·3	+ 1·7
5	31	2405587	2405563·2	+23·8	2405571·3	+15·7
6	23	2408066	2408073·0	− 7·0	2408070·5	− 4·5
7	22	2408375	2408385·8	−10·8	2408382·5	− 7·5
8	21	2408688	2408697·9	− 9·9	2408694·1	− 6·1
9	20	2408998	2409009·4	−11·4	2409005·3	− 7·3
10	19	2409321	2409320·3	+ 0·7	2409316·2	+ 4·8
11	18	2409637	2409630·4	+ 6·6	2409626·7	+10·3
12	17	2409934	2409939·7	− 5·7	2409936·7	− 2·7
13	16	2410249	2410248·2	+ 0·8	2410246·2	+ 2·8
14	15	2410558	2410556·1	+ 1·9	2410555·3	+ 2·7
15	13	2411177	2411170·0	+ 7·0	2411172·0	+ 5·0
16	12	2411471	2411476·1	− 5·1	2411479·7	− 8·7
17	10	2412099	2412087·3	+11·7	2412094·1	+ 4·9
18	9	2412406	2412392·7	+13·3	2412400·7	+ 5·3
19	8	2412701	2412698·7	+ 2·3	2412707·1	− 6·1
20	7	2413012	2413003·5	+ 8·5	2413013·4	− 1·4
21	6	2413325	2413309·3	+15·7	2413319·5	+ 5·5
22	2	2414548	2414537·2	+10·8	2414543·9	+ 4·1
23	1	2414848	2414845·7	+ 2·3	2414750·3	− 2·3
24	0	2415157	2415155·0	+ 2·0	2415156·9	+ 0·1
25	+1	2415465	2415465·1	− 0·1	2415463·9	+ 1·1

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To determine if any correction to the elements of variation :—

$$\text{(I.)}\quad M = 2415180 + 309^{d}\cdot 7\,E + 25^{d}\cos(10^{\circ}\,E - 180^{\circ})$$

would better satisfy the recorded observations, differential equations were formed from the above elements, and these being solved gave a system of corrections. Once more with the corrected elements a new set of differential equations was formed, and these gave as a final result :—

$$\text{(II.)}\quad M = 2415172 + 309^{d}\cdot 3\,E + 23^{d}\cos(8^{\circ}\cdot 2\,E - 229\cdot 1^{\circ})$$

The dates of maximum phase computed from these elements are given in column 6 of the preceding table, and the residuals in column 7.

The average residual computed from elements I. is

7·5 days ;

and the average residual computed from elements II.

5·3 days.

In order to exhibit the systematic variation in the duration of the period of *R Carinæ* in a more evident form, Plate 17 represents the discordances between observed and computed dates when the systematic correction

$$23^{d}\cos(8^{\circ}\cdot 2\,E - 229^{\circ}\cdot 1)$$

is left out of account. The dotted curve in the figure is this systematic correction.

In this connection, however, it may be as well, in case of misapprehension, to point out that we have no certain assurance, and cannot have any for many years to come, that an expression of the form

$$a\cos(\theta E - M)$$

describes the secular irregularities affecting the period of *R Carinæ.*

It is assumed that the irregularities are of this nature, but until a full cycle is completed the assumption must have the character of an empirical explanation.

If we select a period of 309·7 days, one of the limits, it will be found that the residuals, when graphically represented, may be expressed under the form

$$a\cos(\theta E - M) + \beta\cos(2\theta E - N)\ ;$$

and this curve will as readily satisfy the discordances as the former.

Every year is, however, making a definite solution more possible, and in ten more years there will be sufficient data to

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determine rigorously the amplitude and duration of the cycle of inequalities.

Meantime the curve given in Plate 17, and the elements set forth in Equation II., may be taken as generally descriptive of these inequalities, and any further and more refined consideration of fuller material will not materially alter the conclusions come to.

Put generally the conclusions are as follows :—

(1) The mean period of *R Carinæ* is 309·3 days, but this value varies from 305·8 days as one limit, to 312·8 days as the maximum limit.

(2) The lower limit was passed in 1896, and the maximum limit in 1877.

(3) At present (1901) the duration of the period is 307·4 days and is increasing.

(4) A full cycle of periodic inequalities is completed in 37 or 38 years.

One is tempted to wander into speculation as to the cause, or causes, of this anomaly ; but until we know more about the conditions of motion, or about the chemical changes, or about both combined, that produce the type of long period variation that we find in stars of the same class as *R Carinæ*, such excursions are unprofitable.

I think, however, the solution of the problem would be advanced materially if at each recurring maximum careful measures were made of the motion in the line of sight of the brighter variables. It could then be determined if this long period inequality is in any way connected with orbital movement.

Lovedale, South Africa:
1901 *May* 9.

Measures of Double Stars made at Mr. Edward Crossley's Observatory, Bermerside, Halifax. By Joseph Gledhill.

The following measures of a selected list of important binary stars have been made with the Cooke Equatorial and Simms' Micrometer. Up to 1896 the object-glass was the $9\frac{1}{3}$-inch Cooke ; since that year a 9-inch photo-visual object-glass by the same makers has been used. The power most used was 290 ; occasionally 480 was used with advantage.

The usual method of measurement with a parallel-wire micrometer was followed.

Distances are almost always difficult to measure here owing to the unsteady air ; hence it is that most of the distances under 1″ recorded below are rather careful estimations than measures. Very few years afford half a dozen nights good enough for measures of distances under 1″.

The R.A. and dec. are for 1900. When two or more sets of measures have been made in one year the mean value is given.